The Laws of Nature Also Apply to Human Society

Alenka Gaberščik[1]

Abstract

The contribution summarises basic laws and principles ruling processes in nature. It discusses the relationship between human society and Earth as a system. Further, it underlines the importance of understanding interactions in the biosphere with other compartments of our planet, as well as basic concepts related to the protection of the environment and of nature. On the basis of EU legislation related to biodiversity and biofuels, it points out the gaps which prevent efficient protection of the environment and of nature, and stresses the importance of harmonised action on the planet.

Keywords

Laws of Nature, Human Society, Biosphere

I. Introduction

Our planet is a biogenic system. The through-flows of energy and cycling of matter occur via a web of organisms and influence all spheres of our planet: atmosphere, hydrosphere, lithosphere including pedosphere and biosphere. Changes in one component might drastically affect another, as was shown by the effects of deforestation of tropical forests on the atmosphere and climate (Phat et al., 2004). Organisms shape their environment through metabolic processes and activity. *Vice versa*, environmental conditions affect their vitality and efficiency. Humans are just one out of millions of species living on Earth; however, the impact of humans on Earth could be compared to the most catastrophic events in Earth's history. The simple equation of the carbon balance shows that responsibility for the present condition is mainly ours. The recent increase of greenhouse gases, pollution and degradation of ecosystems has resulted in the deterioration of the living environment of organisms, as well as in the decreased quality and availability of our resources.

In 2006, James Lovelock, the author of the famous Gaia theory, which postulates that the biosphere is a self-regulating entity with the ability to keep our planet healthy by controlling the environment (Lovelock, 2000) published a new book titled »The revenge of Gaia« (Lovelock, 2006). In this book he applies the Gaia theory to climate change, taking into account the scientific background and pointing out human responsibility. However, this title is only figurative. If we summarise all the pressures exerted on our planet by humans, we can hardly claim that the events we are witnessing today are revenge. The transformation of the biosphere affected all spheres of our planet, resulting in a reduction of planetary biodiversity and disturbed biotic mechanisms of environmental control, as

[1]Biotechnical Faculty, University of Ljubljana, Večna pot 111, 1001 Ljubljana, Slovenija. E-mail: alenka.gaberscik@bf.uni-lj.si.

well as in Gaia's capacity to maintain stable environmental conditions and buffer human activities, which collide with basic laws ruling nature. Therefore the title »Gaia cannot keep up« would fit the situation much better.
When did we get so far off track? There are three answers to this question. (1) The problems started with the beginning of agriculture, when we occupied land belonging to other organisms and became "conquerors" instead being equals among equals. (2) There is a lack of awareness that Earth holds a limited supply of resources. (3) We are also not aware that we should respect rules which govern the lives of all organisms on the planet.

II. Laws of nature

The main purpose of rules and legislation in human society is to maintain safety and order. Processes in nature are subject to physical laws related to matter and energy. The most important of these are the laws of thermodynamics, because all manifestations of life are closely related to energy changes (Odum, 1971). The sum of the evolutionary processes (selection, mutation, migration and genetic drift) that are based on these laws have created biotic diversity on our planet. Natural systems possess essential thermodynamic properties that are able to support high levels of internal order, which is related to complex biomass structure. The evolution of natural systems was directed towards increased complexity and a balance between anabolic and catabolic processes. It is a long-lasting process favouring species that are well-attuned to a given environment, being able to use resources and energy the most efficiently. In a stable environment, different species are intimately interrelated, forming a higher level of optimized functional units (ecosystems). Under more or less constant conditions, these systems show a high level of sustainability. Any change of system structure or environmental conditions due to disturbance to the system shifts the system from its balance and affects energy and matter use efficiency.
How can we summarise the main principles that rule nature? From today's knowledge about structural and functional properties of natural systems, we can extract four basic principles. (1) The historical remains of biota show that adaptations of organisms with a longer life span were only possible in the long term. Gradual development resulted in well "equipped" (adapted) organisms in a given environment and any quick change would make this "equipment" useless. (2) Organisms are the carriers of the cycling of matter and through-flow of energy. The efficiency of the cycling of matter and through-flow of energy in the ecosystem depends on relations among organisms, on the complexity of the food web and on environmental factors determining the type of ecosystem. (3) The success of any species in the ecosystem is related to the efficient use of natural resources (matter and energy). (4) The growth of the population of certain species (including humans) is limited by the carrying capacity of the environment, that is the potential of the environment to support vital population. In spite of the fact that the majority of people live in very modest conditions having limited access to basic resources, the carrying capacity of Earth, has already been exceeded. In vital, healthy, undisturbed ecosystems with favourable environmental conditions, these principles support sustainability, the development of the systems towards higher complexity and enable their self-regulation. There are many other rules

and principles related to specific processes (i.e. population dynamic, interactions between organisms, ecological succession, . . .), but they are more or less subjected to the principles listed above.

III. Human society as part of the system of Earth

For a long time humans presented a negligible part of life, having little impact on Earth. However, the situation changed about 11,000 years ago, when humans settled down and became farmers. Since that time, the population and our impact have increased substantially. Human disturbance of natural systems (populations, ecosystems) has been increasing the ratio of catabolic vs. anabolic processes, resulting in an increase of system entropy or disorder. The atmosphere is the most sensitive sphere of our planet, reflecting processes on Earth's surface. The most evident change showing the prevalence of catabolic processes are increasing concentrations of greenhouse gasses and consequently increasing temperatures.

At this point we should clarify the status of human society within the Earth system. As Earth dwellers, we are primarily subject to laws of nature and only secondarily to human laws. Therefore, for the understanding of our position it is crucial to understand global dynamics and processes in nature, as well as the rules and principles that govern species prosperity. The question as to how prosperous human society is with regard to basic principles leads to some other questions. Why did we change the planet so much? What was the driving force behind the process? Was it greed, ignorance or an inability to control our activities? The answer to these questions is very complex. Greed is related to our values and priorities, which are, in modern society, far from consistent with the basic principles of nature. However, we can deal with ignorance and control, since we have well-developed educational and legislation systems and through those can also affect our values.

Odum and Barret (2005) pointed out the gaps that prevent harmony between the environment and human society: income gap (rich and poor), food gap (well-fed and underfed people), value gap (market and nonmarket goods and services), education gap (literate and illiterate people) and resource management gap (development and stewardship). These gaps intensify inconsistencies on our planet and prevent sustainability, since the precondition for sustainable development is not only equality among generations, but also equality among people sharing the planet. One of the crucial problems governing these gaps is non-harmonised legislation when comparing different parts of Earth, as well as the unbalanced consideration of social and environmental aspects. Besides that, the understanding of a single gap might vary to great extent. For example, if we are speaking about the education gap, we can understand literacy and illiteracy in different ways. With regard to our attitude to the environment, it is related to our preferences in life, our awareness and knowledge of the structure and function of natural systems. From this point of view, a special type of literacy, i.e. the knowledge of "reading" nature is needed. Even though we are fully dependent on nature, the average citizen of this planet hardly understands its function. The problem is that in the past we have had very loose and superficial "instructions" on how to manage nature and in many parts of Earth and in some aspects also in Europe, this is still the case.

IV. Consistency of existing instructions

Case study: biodiversity vs. biofuels

Carbon dioxide in the atmosphere was more or less stable for about 20 million years. This was a consequence of geochemical processes and a long-term dynamic equilibrium between anabolic and catabolic processes in the biosphere that were (and still are) the major factors maintaining the gas composition in the atmosphere. It is suspected that the carbon dioxide bursts that have occurred several times in the planet's history were the consequence of catastrophic events and consequently disequilibrium between anabolism and catabolism. Nowadays, multiple changes driven by human activities have affected biota to the extent that species loss is 100 to 1000 times higher than it had been without human influence (Millennium Ecosystem Assessment, 2005).

The EU biodiversity strategy (COM (2011) 244) was established to stop biodiversity loss (up to 2020) and to prepare a basis for the transition of our society toward increased resource use efficiency and an environment-friendlier, climate-resilient, low carbon economy. The strategy defines the following inter-dependent targets, i.e. (1) conserving and restoring nature (by implementing Bird and Habitat Directive as per Natura 2000), (2) maintaining and enhancing the resilience of ecosystems and their services, (3) ensuring the sustainability of agriculture, forestry and fisheries, (4) combating invasive alien species, (5) addressing the global biodiversity crisis and (6) contributions from other environmental policies and initiatives. These targets collide with other activities and directives, including Council Directive 2009/28/EC regulating biofuel and bioliquid production.

The use of biomass as an energy source started 160,000 years ago. Today, traditional sources of energy account for 10–13% of all energy. Nowadays, the use of biomass presents one of the measures of the EU to reduce carbon dioxide emissions and to mitigate climate change. The production of biofuels and bioliquids is based on plant production and other biotic material (agricultural and forestry wastes). Biomass for biofuels could be the result of plant production on existing agricultural areas that had been used for food production or on plantations that were established in areas previously colonised by natural vegetation (forests, bushland, . . .). The culturing of plants for biofuels provides ecosystem services (raw materials) and compromises others. In many cases, the culturing of plants for biofuels presents a threat to biodiversity, because of habitat destruction, overexploitation, the spreading of invasive species, pollution and climate change. Land use changes increase greenhouse gas emissions and changes in the local or regional water cycle. Harvesting all crop residues decreases soil fertility and increases erosion (Gomiero et al., 2010). Tilman et al. (2009) stated that strict rules considering the full life cycle of biofuel production, transformation, and combustion are needed to measure the impacts of biofuels on the efficiency of the global food system, greenhouse gas emissions, soil fertility, water and air quality, and biodiversity.

Biofuel and bioliquid production is regulated by Council Directive 2009/28/EC. The Directive includes a detailed list of sustainability criteria (Article 17). Sustainability criteria should be taken into account irrespective of the fact that raw materials are cultivated inside or outside the European community. Agricultural raw materials cultivated in the EC should meet the standards of Council regulations (Annex II (EC) no. 73/2009) and should follow the minimum requirements for good agricultural and environmental conditions, as defined in Article 6 (1). The Directive also includes additional mechanisms, namely a bonus system for the use of degraded land and a subquota system for non-crop biofuel. The former might be a problem, since degraded land only supports less productive plants. The directive mainly includes measures to prevent direct effects on biodiversity, even though research shows that, in Europe, the indirect effects on biodiversity are much greater than the direct effects (Hellman and Verburg, 2010). The directive is deficient in the promotion of sustainable agriculture practices which would exert less effect on biodiversity (Henneberg et al., 2010). The problem is also the absence of mechanisms to control sustainability during production. Anyhow, some authors claim, that when taking into account a sustainable approach, the biomass potential for biofuel production decreases significantly (Dornburg et al., 2010; Gomiero et al., 2010).

Efficiency analyses should also be performed when choosing cultivation areas. In Europe, forest presents the ultimate environment that would develop on the majority of territory in the absence of human influence. The abandonment of fields leads to rapid succession, i.e. the overgrowing of old fields by woody vegetation. In early successional stages, forest ecosystems present an important carbon sink, and therefore the maintenance of agricultural areas results in a positive carbon balance. Problems might be caused by interference with natural ecosystems due to biomass removal (e.g. from forests) that disturb the structure and function and might result in a changed balance of macro and micro element concentration, the loss of substrate and habitats for numerous organisms and a decrease of their resilience.

The missing aspects related to the effects of biofuel production on biodiversity should be included in legislation. Here are some of them: (1) When defining areas of special value, a case-by-case approach should be used and all aspects of biodivesity, as well as soil quality should be taken into account. (2) A step-by-step approach would enable the control of sustainability during production and use. (3) Additional measures are needed to mitigate the indirect effects on biodiversity and to prevent the compromising of supporting ecosystem services. (4) Worldwide harmonisation of legislation would prevent the "exporting of local problems". (5) For the reduction of CO_2 levels, we should rely more on natural processes functioning as a sink of carbon (i.e. sustainable agriculture, reforestation, forest succession). Since there is strong evidence that today's changes are mainly a consequence of human violations of nature and non-sustainable management of natural resources, adopting laws of nature that would support sustainability is our only possible future.

V. Conclusion

Humans (Homo sapiens) are relatively young species. We appeared only about 200,000 years ago, which is too short for verification of the species success. Besides that, our ancestors lived the majority of this period in close relation to nature. The way of life after beginning of agriculture gradually alienated humans from nature. The understanding of natural processes and the awareness of their full dependence on nature were slowly disappearing. Human population was quickly increasing as well as the need for natural resources. At present the overall ecological footprint of humans exceeded the carrying capacity of the Earth. There is also strong evidence that today's changes of the planet are mainly a consequence of human violations of nature and non-sustainable management of natural resources, therefore adopting laws of nature that would support sustainability is our only possible future and the chance to prove ourselves as a successful species.

References

Communication from the Commission to the European Parliament, The Council, The Economic and Social committee and The Committee of the Regions of May 3, 2011, on Our life insurance, our natural capital: an EU biodiversity strategy to 2020, COM (2011) 244

Council Directive 2009/28/EC of the European Parliament and of the Council of April 23, 2009, on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC

Council Regulation 2009/73/ EC of January 19, 2009, establishing common rules for direct support schemes for farmers under the common agricultural policy and establishing certain support schemes for farmers, amending Regulations (EC) 1290/2005, (EC) 247/2006, (EC) No 378/2007 and repealing Regulation (EC) 1782/2003

Dornburg, V., van Vuuren, D., van de Ven, G., Langeveld, H., Meeusen, M., Banse, M., van Oorschot, M., Ros, J., van den Born, G. J., Aiking, H., Londo, M., Mozaffarian, H., Verweij, P., Lyseng, E., Faaij, A. (2010). Bioenergy revisited: key factors in global potentials of bioenergy. *Energy and Environmental Science*, 3, 258–267.

Gomiero, T., Paoletti, M. G. and Pimentel, D. (2010). Biofuels: Efficiency, ethics, and limits to human appropriation of ecosystem services. *Journal of Agricultural and Environmental Ethics*, 23, 403–434.

Hellmann F., Verburg, P. H. (2010). Impact assessment of the European biofuel directive on land use and biodiversity. *Journal of Environmental Management*, 91, 1389–1396.

Hennenberg, K. J., Dragisic, C., Haye, S., Hewson, J., Semroc, B., Savy, C., Wiegmann, K., Fehrenbach, H. and Fritsche, U. R. (2010). The power of bioenergy-related standards to protect biodiversity. *Conservation Biology*, 24, 412–423.

Lovelock, J. (2000) [1979]. *Gaia: A New Look at Life on Earth* (3rd ed.). Oxford: Oxford University Press.

Lovelock, J. (2006). *The Revenge of Gaia: Why the Earth Is Fighting Back – And How We Can Still Save Humanity*. Penguin Celebrations.

Millennium Ecosystem Assessment. (2005). *Ecosystems and Human Well-Being*. Washington DC: World Resource Institute.
Odum, E. P. (1971). *Fundamentals of Ecology* (3rd ed.). Philadelphia: Saunders.
Odum, P. E., Barret, G. W. (2005). *Fundamentals of Ecology* (5th ed.). Thomson Brooks/Cole.
Phat, N. K., Knorr, W., Kim, S. (2004). Appropriate measures for conservation of terrestrial carbon stocks – analysis of trends of forest management in Southeast Asia. *Forest Ecol. Manag.*, 191, 283–299.
Tilman, T., Socolow, R., Foley, J. A., Hill, J., Larson, E., Lynd, L., Pacala, S., Reilly, J., Searchinger, T., Somerville, C., Williams, R. (2009). Beneficial biofuels – the food, energy, and environment trilemma. *Science*, 325, 270–271.